

to change "he" to -- the -- on page 24, line 3.

Claims 16 and 20 correspond to claims 1 and 8 of Patent No. 6,290,614 with the following exceptions:

1. In the first heating step claims 16 and 20 claim a range of 80°F. to about 130°F. rather than 90°F. to about 150°F.;

2. In the second heating step of claims 16 and 20 the lower limit of the temperature range is 80°F. rather than 90°F.

Claim 17 corresponds to claim 3 of Patent No. 6,290,614.

Claim 18 corresponds to claim 5 of Patent No. 6,290,614 except that claim 18 claims a temperature of 140°F. to 170°F. rather than 157°F.

Claim 19 corresponds to claim 6 of the '614 patent.

Request for Interference With Patent No. 6,290,614

Applicant requests that an interference be declared between this application and Patent No. 6,290,614.

Pursuant to 37 C.F.R. 1.607, applicant presents the following proposed counts:

Proposed Count I

A method of producing a golf ball having a cover including a polyurethane, said method comprising:

providing a first reactant which is an isocyanate;

providing a second reactant selected from the group consisting of a polyol, a polyamine, and combinations thereof;

heating said first reactant to a temperature of from about 80°F. to about 150°F.;

heating said second reactant to a temperature of from about 80°F. to about 150°F.;

mixing said first reactant and said second reactant together;

providing a molding assembly defining a molding cavity and having a golf ball component positioned within said molding cavity;

introducing said first reactant and said second reactant into said molding cavity; and

forming a cover layer about said golf ball component from said first reactant and said second reactant, thereby producing said golf ball.

Proposed Count II

A golf ball produced by the method comprising the steps of:

providing a first reactant which is an isocyanate;

providing a second reactant selected from the group consisting of a polyol, a polyamine, and combinations thereof;

heating said first reactant to a temperature of from about 80°F. to about 150°F.;

heating said second reactant to a temperature of from about 80°F. to about 150°F.;

mixing said first reactant and said second reactant together;

providing a molding assembly defining a molding cavity and having a golf ball component positioned within said molding cavity;

introducing said first reactant and said second reactant into said molding cavity; and

forming a cover layer about said golf ball component from said first reactant and said second reactant, thereby producing said golf ball.

Patent Claims Corresponding to the Proposed Counts

Claim 1 of the '614 patent corresponds to Proposed Count I. Claim 1 differs from Proposed Count I with respect to the lower limits of the temperature ranges in the first and second heating steps. The lower limit in claim 1 is 90° and the lower limit in Proposed Count I is 80°. Proposed Count I does not correspond exactly to claim 1 because, pursuant to 37 C.F.R. 1.606, the count shall not be narrower in scope than any application claim or any patent claim designated to correspond to the count. As explained hereinafter, the lower limits of the temperature ranges of the first and second heating steps of claim 16 is 80°, which is the lower limit which is specifically described in applicants' specification.

Claim 8 of the '614 patent corresponds to Proposed Count II except for the lower limit of the temperature ranges in the first and second heating steps for the same reasons as explained with respect to claim 1 and Proposed Count I.

Application Claims Corresponding to the Proposed Counts

Application claim 16 corresponds to Proposed Count I except that the upper limit of the temperature range of the first heating step in claim 16 is 130°F. and the upper limit in Proposed Count I is 150°F. Applicants' specification describes an upper temperature limit of 130°F. for the isocyanate component at page 16, line 19, and page 17, lines 2 and 17.

Application claim 20 corresponds to Proposed Count II except that the upper temperature limit of the first heating step is 130°F. in application claim 20 and 150°F. in Proposed Count II for the same reasons as discussed with respect to application claim 16 and proposed Count I.

**Applying the Terms of Application
Claims 16 and 20 to the Disclosure**

Application claim 16 is supported by the disclosure of applicants' specification as follows:

<u>Elements of Application Claim 16</u>	<u>Disclosure of Specification</u>
A method of producing a golf ball having a cover including a polyurethane, said method comprising;	Page 11, lines 1-4
providing a first reactant which is an isocyanate;	Page 11, line 18 to page 12, line 2
providing a second reactant selected from the group consisting of a polyol, a polyamine, and combinations thereof;	Page 12, lines 3-14
heating said first reactant to a temperature of from about 80°F. to about 150°F. 130°F	Page 17, lines 16-18
heating said second reactant to a temperature of from about 80°F. to about 150°F.	Page 17, lines 14-15
mixing said first reactant and	Page 12, line 20 to page

said second reactant together;	13, line 10; page 17, line 21 to page 18, line 22
providing a molding assembly defining a molding cavity and having a golf ball component positioned within said molding cavity.	Page 13, line 11 to page 14, line 10; page 17, lines 21-24; page 18, lines 15-17
introducing said first reactant and said second reactant into said molding cavity; and	Page 17, line 25 to page 18, line 22
forming a cover layer about said golf ball component from said first reactant and said second reactant, thereby producing said golf ball.	Page 13, line 24 to page 14, line 10; page 19, lines 1-5 and lines 23- 24; page 21, lines 1-3

Claim 18 describes a golf ball produced by a method which comprises the steps of claim 16 and is supported by the specification in the same manner as claim 16.

35 U.S.C. 135(b) Is Not Applicable

The requirements of 35 U.S.C. 135(b) are not applicable because this amendment and the claims added thereby was filed less than one year after the issue date of the '614 patent.

**The Effective Filing Date of Application
Claims 16-20 is October 21, 1998**

This application is a continuation-in-part of Serial No. 09/176,445, filed October 21, 1998. For the Examiner's convenience, a copy of Serial No. 09/176,445 is attached as Exhibit A.

Application claims 16-20 are fully supported by Serial No. 09/176,445, and the effective filing date of application claims 16-20 is October 21, 1998.

Application Claim 16

Disclosure of Serial

No. 09/176,445

A method of producing a golf ball having a cover including a polyurethane, said method comprising;

Page 5, lines 8-11

providing a first reactant which is an isocyanate;

Page 5, line 25 to page 6, line 10

providing a second reactant selected from the group consisting of a polyol, a polyamine, and combinations thereof;

Page 6, lines 11-22

heating said first reactant to a temperature of from about 80°F. to about 150°F.; (not

Page 10, lines 3-5

heating said second reactant to a temperature of from about 80°F. to about 150°F.

Page 10, lines 1-2

mixing said first reactant and said second reactant together;

Page 7, lines 2-18; page 10, line 14 to page 11, line 10

providing a molding assembly defining a molding cavity and having a golf ball component positioned within said molding cavity.

Page 7, line 19 to page 8, line 5; page 10, lines 9-11; page 11, lines 3-5

introducing said first reactant and said second reactant into said molding cavity; and

Page 10, line 12 to page 11, line 10

forming a cover layer about said golf ball component from said first reactant and said second reactant, thereby producing said golf ball.

Page 3, line 22 to page 4, line 1; page 5, lines 8 to 11; line 8 to page 11; page 8, lines 6-18; page 11, lines 15-19

Application Claim 17

**Disclosure of Serial
No. 09/176,445**

The method of claim 1 wherein said second reactant is a polyol.

Page 6, lines 11-22

Application Claim 18

**Disclosure of Serial
No. 09/176,445**

The method of claim 1 further comprising: heating said molding assembly to a temperature of about 140°F. to 170°F.

Page 10, lines 6-7

Application Claim 19

**Disclosure of Serial
No. 09/176,445**

The method of claim 1 further comprising: adding a density-increasing filler to at least one of said first reactant and said second reactant.

Page 6, line 25 to page 7, line 1

Application claim 20 describes a golf ball produced by the method of application claim 16 and is supported by Serial No. 09/176,445 in the same manner as application claim 16.

**The Effective Date of Patent
No. 6,290,614 is October 1, 1999**

The '614 patent was filed as Serial No. 09/411,690 on October 1, 1999. The application was identified as a continuation-in-part of application No. 09/040,798, filed on March 18, 1998. However, the claims of the '614 patent are not supported by Serial No. 09/040,798, and the effective filing date of the claims of the '614 patent is therefore October 1, 1999.

For the convenience of the Examiner, Serial No. 09/040,798 is attached hereto as Exhibit B.

Claim 1 of the '614 patent describes a first heating step in which the first reactant is heated to a temperature of from about 90°F. to about 150°F. The first reactant is an isocyanate. The broadest temperature range for heating the first reactant which is disclosed in Serial No. 09/040,798 is 100 to 150°F. as disclosed on page 9, line 5. Serial No. 09/040,978

does not describe a lower limit for the temperature range of the first heating step below 100°F.

Claim 1 of the '614 patent describes heating the second reactant to a temperature of from about 90°F. to about 150°F. The second reactant is selected from the group consisting of a polyol, a polyamine, and combinations thereof. The broadest temperature range for heating the second reactant which is disclosed in Serial No. 09/040,798 is 100 to 150°F. on page 9, line 5. Serial No. 09/040,798 does not disclose a lower limit for the temperature range of the second heating step below 100°F.

Hyatt v. Boone, 146 F.3d 1348 (Fed. Cir. 1998), was an interference case in which Hyatt attempted to obtain the benefit of the filing date of an earlier patent application. The Federal Circuit held that Hyatt was not entitled to the earlier filing date:

"For an earlier-filed application to serve as constructive reduction to practice of the subject matter of an interference count, the applicant must describe the subject matter of the count in terms that establish that he was in possession of the later-claimed invention, including all of the elements and limitations presented in the count, at the time of the earlier filing."

"Thus, the written description must include all of the limitations of the interference count, or the applicant must show that any absent text is necessarily comprehended in the description provided and would have been so understood at the time the patent application was filed."

Similarly, the claims of the '614 patent are not entitled to the filing date of Serial No. 09/040,798 because the '798 application does not describe the lower temperature limit of the claims.

**The Requirements of 37 C.F.R.
1.608 Are Not Applicable**

37 C.F.R. 1.608 (a) requires a statement alleging that there is a basis upon which the applicant is entitled to a judgment relative to the patentee when the effective filing date of an application is three months or less after the effective filing date of a patent. 37 C.F.R. 1.608(b) states that when the effective filing date of an application is more than three months after the effective filing date of a patent, the applicant shall file evidence in one or more affidavits which demonstrate that applicant is prima facie entitled to a judgment relative to the patentee.

Since application claims 16-20 are entitled to a filing date of October 21, 1998 and since the claims of the '614 patent are not entitled to a filing date any earlier than October 1, 1999, the requirements of 37 C.F.R. 1.608(a) and (b) are not applicable.

**Application Claims 16-20 Cannot
Be Rejected Under 35 U.S.C. 102(e)**


Pursuant to MPEP §2307.02, the Examiner must determine whether applicant's new claims are unpatentable to the applicant on any grounds, e.g., under 35 U.S.C. 102, 103, 112, 135(b), double patenting, etc. Application claims 16-20 cannot be

rejected under 35 U.S.C. 102(e) on the basis of the parent application of the '614 patent, namely, 09/040,798, because applicants conceived and reduced to practice the invention before the filing date of Serial No. 09/040,798 as stated in a Declaration Under 37 C.F.R. 1.131 which will be filed in the near future. Alternatively, applicants conceived of their invention prior to the filing date of Serial No. 09/040,798 and exercised diligence from prior to said filing date to a subsequent reduction to practice as stated in the Declaration.

Conclusion

In view of the foregoing, applicants respectfully request that an interference be declared between this application and Patent No. 6,290,614.

Respectfully submitted,



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Replacement Paragraph for Page 7, lines 2-9

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Thermoset materials used as covers for golf balls are all described as having either half-shells or material in its pre-cure form (urethane) introduced into an open mold, closing the mold, molding the cover under sufficient heat and pressure and allowing it to cure sufficiently to de-mold, cooling the mold, and removing the molded part from the mold. In some cases, a post-curing step is required to complete the curing of the thermoset material.

Version of Page 7, lines 2-9 With Markings To Show Changes Made

Thermoset materials used as covers for golf balls are all described as having either half-shells or material in its pre-cure form (urethane) introduced into an open mold, closing the mold, molding the cover [until] under sufficient heat and pressure and allowing it to cure sufficiently to de-mold, cooling the mold, and removing the molded part from the mold. In some cases, a post-curing step is required to complete the curing of the thermoset material.

Replacement Paragraph for Page 20, lines 13-14

Components were balanced to produce acceptable ratio
(as defined in Table 1) to produce reacted product.

Version of Page 20, lines 13-14
With Markings To Show Changes Made

Components were balanced to produce acceptable [ration]
ratio (as defined in Table 1 to produce reacted product.

Replacement Paragraph for Page 23, line 25 to Page 24, line 7

3
The golf ball of Example 4 was compared to the Staff Titanium Balata golf ball, which utilizes the same core/mantle construction as used in Example 4, but utilizes a cover comprising a balata/polybutadiene blend, which is compression molded around the solid cores. Results indicate that the ball molded using the reaction injection molding process produces comparable cover hardness (Shore "D") to the Staff Titanium Balata, and compression (Atti) and resilience properties that would be considered acceptable for a premium golf ball.

**Version of Page 23, line 25 to Page 24,
Line 7 With Markings To Show Changes Made**

The golf ball of Example 4 was compared to the Staff Titanium Balata golf ball, which utilizes the same core/mantle construction as used in Example 4, but utilizes a cover comprising a balata/polybutadiene blend, which is compression molded around the solid cores. Results indicate that [he] the ball molded using the reaction injection molding process produces comparable cover hardness (Shore "D") to the Staff Titanium Balata, and compression (Atti) and resilience properties that would be considered acceptable for a premium golf ball.



**GOLF BALL WHICH INCLUDES
FAST-CHEMICAL-REACTION-PRODUCED
COMPONENT AND METHOD OF MAKING SAME**

Field and Background of the Invention

5 The invention relates generally to golf balls, and more particularly to golf balls which contain a fast-chemical-reaction-produced component, such as a core and/or cover layer.

 Golf balls comprise, in general, three types. The first type is a multi-piece wound ball wherein a vulcanized rubber thread is wound under tension around a
10 solid or semi-solid core, and thereafter enclosed in a single or multi-layer covering of a tough, protective material. A second type of a golf ball is a one-piece ball formed from a solid mass of resilient material which has been cured to develop the necessary degree of hardness to provide utility. One-piece molded balls do not have a second enclosing cover. A third type of ball is a
15 multi-piece non-wound ball which includes a liquid, gel or solid core of one or more layers and a cover having one or more layers formed over the core.

 Conventional golf ball covers have been made of ionomer, balata, and slow-reacting, thermoset polyurethane. When polyurethane covers are made by conventional methods, such as by casting, a substantial amount of time and
20 energy are required, thus resulting in relatively high cost.

 It would be useful to develop a golf ball containing a fast-chemical-reaction-produced component, such as at least one core or cover layer, particularly one which contains polyurethane, polyurea, epoxy and/or unsaturated polyester.

25 **Summary of the Invention**

 An object of the invention is to produce a golf ball having a polyurethane cover which is formed by a fast chemical reaction.

 Another object of the invention is to provide a non-ionomeric golf ball cover which is efficiently produced by injection molding.

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Yet another object of the invention is to provide a golf ball which contains polyurethane.

A further object of the invention is to provide a golf ball in which material from recycling polyurethane can be used to result in an efficient manufacturing
5 process.

A further object of the invention is to produce a durable golf ball containing polyurethane, polyurea, epoxy, and/or unsaturated polyesters.

Another object of the invention is to provide a golf ball with a "seamless" cover layer, i.e., a cover layer having generally the same microscopic and
10 molecular structure distribution both in the regions adjacent to the parting line of the mold and at locations which are not adjacent to the parting line, including near the poles.

Yet another object of the invention is to provide a method of making a golf ball of the type described above.

15 Other objects of the invention will become apparent from the specification, drawings and claims.

A preferred form of the invention is a method of making a multi-piece golf ball comprising making at least one of a cover component and a core component of the ball by mixing two or more materials that react to form a
20 reaction product with a flex modulus of 5 - 310 kpsi in a reaction time of about 5 minutes or less, the component having a thickness of at least 0.01 inches and a demold time of 10 minutes or less including the reaction time.

The composition preferably comprises at least one member selected from the group consisting of polyurethanes, polyureas, epoxies and unsaturated
25 polyesters. The reaction product preferably is formed by reaction injection molding. The component preferably has a thickness of at least 0.02 inches.

Another preferred form of the invention is a multi-piece golf ball comprising a reaction injection molded material comprising polyurethane/polyurea. The golf ball cover preferably has a Shore D hardness
30 in the range of 20 - 95, more preferably 30 - 75, and a flex modulus in the range

of 5 - 310 kpsi, and more preferably 5 - 100 kpsi and even more preferably 10 - 80 kpsi. Preferably, at least 5% of the polyurethane/polyurea is formed from molecules obtained by recycling a material comprising at least one of polyurethane, polyurea, polyester and polyethylene glycol.

5 Yet another preferred form of the invention is a process for producing a golf ball including the step of reaction injection molding a polyurethane/polyurea material to form at least one of a core layer and a cover layer of the ball.

A further preferred form of the invention is a process for producing a golf
10 ball comprising the steps of (a) reaction injection molding a polyurethane/polyurea component of the ball, and (b) recycling some of the polyurethane and/or polyurea that is produced in connection with step (a) but that is not incorporated in the golf ball in step (a). The polyurethane/polyurea preferably, but not necessarily, is recycled by glycolysis.

15 Yet another preferred form of the invention is a process for producing a golf ball comprising (a) forming a core, (b) covering the core, and (c) coating and adding indicia to the covered ball, wherein at least one of steps (a) and (b) comprises reaction injection molding of a polyurethane and/or polyurea material.

20 The golf ball of the invention can include, in the cover, optical brighteners, white pigment, UV stabilizers, antioxidants, etc. The cover and/or core may further include fillers such as TiO_2 , glass, metal, and other fillers described below.

Yet another preferred form of the invention is a golf ball having a cover
25 comprising a blend of polyurethane and ionomer, wherein the ionomer is a partially cation neutralized organic acid polymer, preferably an alpha, beta unsaturated carboxylic acid with 3 or more carbon atoms. The ionomer may be a polyurethane ionomer.

A further preferred form of the invention is a golf ball comprising at least one fast-chemical-reaction-produced layer, said layer having a flex modulus of 5 - 300 kpsi in a reaction time of 5 minutes or less and a thickness of at least 0.01".

- 5 Yet another preferred form of the invention is a golf ball having a core and a cover, the cover comprising polyurethane/polyurea which is formed from reactants, 5 - 100 weight percent of which are obtained from recycled polyurethane.

Brief Description of the Drawings

- 10 Fig. 1 is a first embodiment of a golf ball formed according to a reaction injection molded (RIM) process according to the invention.

Fig. 2 is a second embodiment of a golf ball formed according to a reaction injection molded (RIM) process according to the invention.

- 15 Fig. 3 is a third embodiment of a golf ball formed according to a reaction injection molded (RIM) process according to the invention.

Fig. 4 is a process flow diagram which schematically depicts a reaction injection molding process according to the invention.

Fig. 5 schematically shows a mold for reaction injection molding a golf ball cover according to the invention.

20 Detailed Description of the Invention

- The present invention is a golf ball in which at least one cover or core layer is a fast-chemical-reaction-produced component. This component comprises at least one material selected from the group consisting of polyurethane, polyurea, polyurethane ionomer, epoxy, and unsaturated
25 polyesters, and preferably comprises polyurethane. The invention also includes a method of producing a golf ball which contains a fast-chemical-reaction-produced component. A golf ball formed according to the invention preferably has a flex modulus in the range of 5 - 310 kpsi, a Shore D hardness in the range of 20 - 90, and good durability. Particularly preferred
30 forms of the invention also provide for a golf ball with a

fast-chemical-reaction-produced cover having good scuff resistance and cut resistance. As used herein, "polyurethane and/or polyurea" is expressed as "polyurethane/polyurea".

A particularly preferred form of the invention is a golf ball with a cover comprising polyurethane, the cover including 5 - 100 weight percent of polyurethane formed from recycled polyurethane.

The method of the invention is particularly useful in forming golf balls because it can be practiced at relatively low temperatures and pressures. The preferred temperature range for the method of the invention is 120 - 180°F when the component being produced contains polyurethane. Preferred pressures for practicing the invention using polyurethane-containing materials are 200 psi or less and more preferably 100 psi or less. The method of the present invention offers numerous advantages over conventional slow-reactive process compression molding of golf ball covers. The method of the present invention results in molded covers in a demold time of 10 minutes or less. An excellent finish can be produced on the ball.

The method of the invention also is particularly effective when recycled polyurethane or other polymer resin, or materials derived by recycling polyurethane or other polymer resin, is incorporated into the product.

As indicated above, the fast-chemical-reaction-produced component can be one or more cover and/or core layers of the ball. When a polyurethane cover is formed according to the invention, and is then covered with a polyurethane top coat, excellent adhesion can be obtained. The adhesion in this case is better than adhesion of a polyurethane coating to an ionomeric cover. This improved adhesion can result in the use of a thinner top coat, the elimination of a primer coat, and the use of a greater variety of golf ball printing inks beneath the top coat. These include but are not limited to typical inks such as one component polyurethane inks and two component polyurethane inks.

The preferred method of forming a fast-chemical-reaction-produced component for a golf ball according to the invention is by reaction injection

molding (RIM). RIM is a process by which highly reactive liquids are injected into a closed mold, mixed usually by impingement and/or mechanical mixing in an in-line device such as a "peanut mixer", where they polymerize primarily in the mold to form a coherent, one-piece molded article. The RIM processes usually involve a rapid reaction between one or more reactive components such as polyether - or polyester - polyol, polyamine, or other material with an active hydrogen, and one or more isocyanate - containing constituents, often in the presence of a catalyst. The constituents are stored in separate tanks prior to molding and may be first mixed in a mix head upstream of a mold and then injected into the mold. The liquid streams are metered in the desired weight to weight ratio and fed into an impingement mix head, with mixing occurring under high pressure, e.g., 1500 - 3000 psi. The liquid streams impinge upon each other in the mixing chamber of the mix head and the mixture is injected into the mold. One of the liquid streams typically contains a catalyst for the reaction. The constituents react rapidly after mixing to gel and form polyurethane polymers. Polyureas, epoxies, and various unsaturated polyesters also can be molded by RIM.

RIM differs from non-reaction injection molding in a number of ways.

The main distinction is that in RIM a chemical reaction takes place in the mold to transform a monomer or adducts to polymers and the components are in liquid form. Thus, a RIM mold need not be made to withstand the pressures which occur in a conventional injection molding. In contrast, injection molding is conducted at high molding pressures in the mold cavity by melting a solid resin and conveying it into a mold, with the molten resin often being at about 150 - 350°C. At this elevated temperature, the viscosity of the molten resin usually is in the range of 50,000 - 1,000,000 centipoise, and is typically around 200,000 centipoise. In an injection molding process, the solidification of the resins occurs after about 10 - 90 seconds, depending upon the size of the molded product, the temperature and heat transfer conditions, and the hardness of the injection molded material. Subsequently, the molded product is removed from

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the mold. There is no significant chemical reaction taking place in an injection molding process when the thermoplastic resin is introduced into the mold. In contrast, in a RIM process, the chemical reaction typically takes place in less than about two minutes, preferably in under one minute, and in many cases in about 30 seconds or less.

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If plastic products are produced by combining components that are performed to some extent, subsequent failure can occur at a location on the cover which is along the seam or parting line of the mold. Failure can occur at this location because this interfacial region is intrinsically different from the remainder of the cover layer and can be weaker or more stressed. The present invention is believed to provide for improved durability of a golf ball cover layer by providing a uniform or "seamless" cover in which the properties of the cover material in the region along the parting line are generally the same as the properties of the cover material at other locations on the cover, including at the poles. The improvement in durability is believed to be a result of the fact that the reaction mixture is distributed uniformly into a closed mold. This uniform distribution of the injected materials eliminates knit-lines and other molding deficiencies which can be caused by temperature difference and/or reaction difference in the injected materials. The process of the invention results in generally uniform molecular structure, density and stress distribution as compared to conventional injection-molding processes.

The fast-chemical-reaction-produced component has a flex modulus of 5 - 310 kpsi, more preferably 5 - 100 kpsi, and most preferably 5 - 50 kpsi. The subject component can be a cover with a flex modulus which is higher than that of the centermost component of the cores, as in a liquid center core and some solid center cores. Furthermore, the fast-chemical-reaction-produced component can be a cover with a flex modulus that is higher than that of the immediately underlying layer, as in the case of a wound core. The core can be one piece or multi-layer, each layer can be either foamed or unfoamed, and

density adjusting fillers, including metals, can be used. The cover of the ball can be harder or softer than any particular core layer.

The fast-chemical-reaction-produced component can incorporate suitable additives and/or fillers. When the component is an outer cover layer, pigments or dyes, accelerators and UV stabilizers can be added. Examples of suitable optical brighteners which probably can be used include Uvitex and Eastobrite OB-1. An example of a suitable white pigment is titanium dioxide. Examples of suitable and UV light stabilizers are provided in commonly assigned U.S. Patent No. 5,494,291. Fillers which can be incorporated into the fast-chemical-reaction-produced cover or core component include those listed below in the definitions section. Furthermore, compatible polymeric materials can be added. For example, when the component comprises polyurethane and/or polyurea, such polymeric materials include polyurethane ionomers, polyamides, etc.

15 A golf ball core layer formed from a fast-chemical-reaction-produced material according to the present invention typically contains 0 - 20 weight percent of such filler material, and more preferably 1 - 15 weight percent. When the fast-chemical-reaction-produced component is a core, the additives typically are selected to control the density, hardness and/or COR.

20 A golf ball inner cover layer formed from a fast-chemical-reaction-produced material according to the present invention typically contains 0 - 60 weight percent of filler material, more preferably 1 - 30 weight percent, and most preferably 1 - 20 weight percent.

25 A golf ball outer cover layer formed from a fast-chemical-reaction-produced material according to the present invention typically contains 0 - 20 weight percent of filler material, more preferably 1 - 10 weight percent, and most preferably 1 - 5 weight percent.

Catalysts can be added to the RIM polyurethane system starting materials as long as the catalysts generally do not react with the constituent with which

they are combined. Suitable catalysts include those which are known to be useful with polyurethanes and polyureas.

The reaction mixture viscosity should be sufficiently low to ensure that the empty space in the mold is completely filled. The reactant materials
5 generally are preheated to 100 - 150°F before they are mixed. In most cases it is necessary to preheat the mold to, e.g., 100 - 120°F, to ensure proper injection viscosity.

As indicated above, one or more cover layers of a golf ball can be formed from a fast-chemical-reaction-produced material according to the present
10 invention.

Referring now to the drawings, and first to Fig. 1, a golf ball having a cover comprising a RIM polyurethane is shown. The golf ball 10 includes a polybutadiene core 12 and a polyurethane cover 14 formed by RIM.

Referring now to Fig. 2, a golf ball having a core comprising a RIM
15 polyurethane is shown. The golf ball 20 has a RIM polyurethane core 22, and a RIM polyurethane cover 24.

Referring to Fig. 3, a multi-layer golf ball 30 is shown with a solid core 32 containing recycled RIM polyurethane, a mantle cover layer comprising RIM polyurethane, and an outer cover layer comprising ionomer or another
20 conventional golf ball cover material. Non-limiting examples of multi-layer golf balls according to the invention with two cover layers include those with RIM polyurethane mantles having a thickness of 0.02 - 0.20 inches and a Shore D hardness of 20 - 80, covered with ionomeric or non-ionomeric thermoplastic, balata or other covers having a Shore D hardness of 20 - 80 and a thickness of
25 0.025 - 0.20 inches.

Referring next to Fig. 4, a process flow diagram for forming a RIM cover of polyurethane is shown. Isocyanate from bulk storage is fed through line 80 to an isocyanate tank 100. The isocyanate is heated to the desired temperature, e.g. 100 - 120°F, by circulating it through heat exchanger 82 via lines 84 and
30 86. Polyol, polyamine, or another compound with an active hydrogen atom is

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conveyed from bulk storage to a polyol tank 108 via line 88. The polyol is heated to the desired temperature, e.g. 100 - 120°F, by circulating it through heat exchanger 90 via lines 92 and 94. Dry nitrogen gas is fed from nitrogen tank 96 to isocyanate tank 100 via line 97 and to polyol tank 108 via line 98.

5 Isocyanate is fed from isocyanate tank 100 via line 102 through a metering cylinder or metering pump 104 into recirculation mix head inlet line 106. Polyol is fed from polyol tank 108 via line 110 through a metering cylinder or metering pump 112 into a recirculation mix head inlet line 114. The recirculation mix head 116 receives isocyanate and polyol, mixes them, and

10 provides for them to be fed through nozzle 118 into injection mold 120. The injection mold 120 has a top mold 122 and a bottom mold 124. Coolant flows through cooling lines 126 in the top mold 122 and lines 128 in the bottom mold 124. The materials are kept under controlled temperature conditions to insure that the desired reaction profile is maintained.

15 The polyol component typically contains additives, such as stabilizers, flow modifiers, catalysts, combustion modifiers, blowing agents, fillers, pigments, optical brighteners, and release agents to modify physical characteristics of the cover. Recycled polyurethane/polyurea also can be added to the core. Polyurethane/polyurea constituent molecules that were derived

20 from recycled polyurethane can be added in the polyol component.

Inside the mix head, injector nozzles impinge the isocyanate and polyol at ultra-high velocity to provide excellent mixing. Additional mixing preferably is conducted using an aftermixer 130, which typically is constructed inside the mold between the mix head and the mold cavity.

25 As is shown in Fig 5, the mold includes a golf ball cavity chamber 132 in which a spherical golf ball mold 134 with a dimpled, spherical mold cavity 136 is positioned. The aftermixer 130 can be a peanut aftermixer, as is shown in Fig 5, or in some cases another suitable type, such as a heart, harp or dipper. An overflow channel 138 receives overflow material from the golf ball mold 134

30 through a shallow vent 136. Cooling water passages 138, which preferably are

in a parallel flow arrangement, carry cooling water through the top mold 122 and the bottom mold 124.

The mold cavity contains retractable pins and is generally constructed in the same manner as a mold cavity used to injection mold a thermoplastic, e.g.,
5 ionomeric golf ball cover. However, a few differences when RIM is used are that tighter pin tolerances generally are required, a lower mold temperature is used, and a lower injection pressure is used. Also, the molds can be produced from lower strength material such as aluminum.

The golf balls formed according to the present invention can be coated
10 using a conventional two-component spray coating or can be coated during the RIM process, i.e., using an in-mold coating process.

One of the significant advantages of the RIM process according to the invention is that polyurethane or other cover material can be recycled and used in golf ball cores. Recycling can be conducted by, e.g., glycolysis. Typically,
15 10 - 80% of the material which is injection molded actually becomes part of the cover. The remaining 20 - 90% is recycled.

Recycling of polyurethanes by glycolysis is known from, for example, RIM Part and Mold Design - Polyurethanes, 1995, Bayer Corp., Pittsburgh, PA. Another significant advantage of the present invention is that because reaction
20 injection molding occurs at low temperatures and pressures, i.e., 120 - 180°F and 100 - 200 psi, this process is particularly beneficial when a cover is to be molded over a very soft core. When higher pressures are used for molding over soft cores, the cores "shut off" i.e., deform and impede the flow of material causing uneven distribution of cover material.

25 One polyurethane component which can be used in the present invention incorporates TMXDI (META) aliphatic isocyanate (Cytec Industries, West Paterson, NJ). Polyurethanes based on meta-tetramethylxylylene diisocyanate can provide improved gloss retention UV light stability, thermal stability hydrolytic stability. Additionally, TMXDI (META) aliphatic isocyanate has
30 demonstrated favorable toxicological properties. Furthermore, because it has a

low viscosity, it is usable with a wider range of diols (to polyurethane) and diamines (to polyureas). If TMXDI is used, it typically, but not necessarily, is added as a direct replacement for some or all of the other aliphatic isocyanates in accordance with the suggestions of the supplier. Because of slow reactivity
5 of TMXDI, it may be useful or necessary to use catalysts to have practical demolding times. Hardness, tensile strength and elongation can be adjusted by adding further materials in accordance with the supplier's instructions.

Golf ball cores also can be made using the materials and processes of the invention. To make a golf ball core using RIM polyurethane, the same
10 processing conditions are used as are described above with respect to covers. One difference is, of course, that no retractor pins are needed in the mold. Furthermore, an undimpled, smaller mold is used. If, however, a one piece ball is desired, a dimpled mold would be used. Polyurethanes also can be used for cores.

15 Golf balls typically have indicia and/or logos stamped or formed thereon. Such indicia can be applied by printing using a material or a source of energetic particles after the ball core and/or cover have been reaction-injection-molded according to the present invention. Printed indicia can be formed from a material such as ink, foil (for use in foil transfer), etc. Indicia printed using a
20 source of energetic particles or radiation can be applied by burning with a laser, burning with heat, directed electrons, or light, phototransformations of, e.g., UV ink, impingement by particles, impingement by electromagnetic radiation etc. Furthermore, the indicia can be applied in the same manner as an in-mold coating, i.e., by applying to the indicia to the surface of the mold prior to
25 molding of the cover.

The polyurethane which is selected for use as a golf ball cover preferably has a Shore D hardness of 40 - 75, more preferably 40 - 60, and most preferably 40 - 50 for a soft cover layer and 50 - 60 for a hard cover layer. The polyurethane which is to be used for a cover layer preferably has a flex modulus

of 5 - 310 kpsi, more preferably 5 - 100 kpsi, and most preferably 5 -20 kpsi for a soft cover layer and 30 - 40 kpsi for a hard cover layer.

Non-limiting examples of suitable RIM systems for use in the present invention are Bayflex® elastomeric polyurethane RIM systems, Baydur® GS solid polyurethane RIM systems, Prism® solid polyurethane RIM systems, all from Bayer Corp. (Pittsburgh, PA), SPECTRIM reaction moldable polyurethane and polyurea systems from Dow Chemical USA (Midland, MI), including SPECTRIM MM 373-A (isocyanate) and 373-B (polyol), and Elastolit SR systems from BASF (Parsippany, NJ). Preferred RIM systems include Bayflex® MP-10000 and Bayflex® 110-50, filled and unfilled. Further preferred examples are polyols, polyamines and isocyanates formed by processes for recycling polyurethanes and polyureas. Peroxides, such as MEK-peroxide and dicumyl peroxide can be used. Furthermore, catalysts or activators such as cobalt octoate 6% can be used.

The following examples are included for purposes of illustration and are not intended to be limiting.

Example 1

A polybutadiene golf ball core having a diameter of 1.545", a PGA compression of about 65 and a coefficient of restitution of about 0.770 was obtained. A dimpled cover having a thickness of 0.0675" was reaction injection molded over the core. The cover comprised Bayflex MP 10000 resin (Bayer). The resulting ball had a PGA compression of 78, a COR of 0.720 and a Shore D cover hardness of 39. The ball met standard durability tests and had an excellent scuff resistance rating of 1. It is expected that this cover also has an excellent cut resistance rating.

Example 2 (Prophetic)

A golf ball core formed from high cis polybutadiene, zinc diacrylate, zinc oxide, zinc stearate, and peroxide initiator is obtained. The core has a diameter of 1.49".

5 The core is covered with a 0.04" thick mantle layer of RIM polyurethane which has a plaque Shore D hardness of 58, namely Bayflex® 110-50 unfilled (Bayer Corp.). The mantle layer is covered with a 0.055" thick dimpled outer cover layer of Iotek 8000, 7510 and 7030, and a whitener package. The formulation and properties of the golf ball are shown below on Table 1.

Example 3 (Prophetic)

A golf ball core formed from high-cis polybutadiene, zinc diacrylate, zinc oxide, zinc stearate and peroxide imitator is obtained. The core has a diameter of 1.49".

10 The core is covered with a 0.040" thick mantle layer of RIM polyurethane having a plaque Shore A hardness of about 90, namely Bayflex® MP 10000 unfilled (Bayer Corp.). The mantle layer is covered with a 0.055" thick dimpled outer cover layer of Ex 1006 and 1007 (Exxon Corp.) and Iotek 7030 (Exxon Corp.). The formulations and properties of the golf ball are shown below in
15 Table 1.

Example 4 (Prophetic)

A golf ball core formed from high-cis polybutadiene, zinc diacrylate, zinc oxide, zinc stearate, and peroxide initiator is obtained. The core has a diameter of 1.49".

20 The core is covered with a 0.055" thick mantle layer of Iotek 1002 and 1003 (Exxon Corp.). The mantle layer is covered with a 0.04" thick dimpled outer cover layer of RIM Bayflex® MP10000 unfilled (Bayer Corp.). The formulation and properties of the golf ball are shown below on Table 1.

Example 5 (Prophetic)

25 A golf ball core having a diameter of 1.42" is formed from an elastomeric unfilled RIM polyurethane (Bayflex® MP10000, Bayer Corp.). The core is covered with a 0.08" thick injection-molded mantle layer of 50 parts by weight Iotek 1002 and 50 parts by weight Iotek 1003. The mantle layer is covered with a 0.050" thick injection-molded outer cover layer of Ex 1006, Ex 1007, Iotek

7030, and whitener. The formulation and properties of the golf ball are shown below on Table 1.

TABLE 1

Chemical Component	Example 2	Example 3	Example 4	Example 5
Core Data				
Size	1.49"	1.49"	1.49"	1.42"
Type				
Polybutadiene	Y	Y	Y	---
RIM Polyurethane	---	---	---	Y
Inner Cover Layer				
Size	1.57"	1.57"	1.57"	1.58"
Weight	38g	---	38g	---
Thickness	0.040"	0.040"	0.055"	0.080"
Hardness (Shore A or D)	58D plaque	90A plaque	70D	70D
Composition (wt %)				
Iotek 1002	---	---	50	50
Iotek 1003	---	---	50	50
Bayflex 110-50 unfilled	100	---	---	---
Bayflex MP 10000	---	100	---	---

TABLE 1
CONTINUED

Outer Cover Layer	Example 2	Example 3	Example 4	Example 5
Hardness (Shore A or D)	57D	64D	90A plaque	64D
Thickness	0.055"	0.055"	0.040"	0.050"
Composition (wt %)				
Bayflex MP 10000	---	---	100	---
Exxon 1006	---	46.4	---	46.4
Exxon 1007	---	46.4	---	46.4
Iotek 8000	33.8%	---	---	---
Iotek 7510	58.9%	---	---	---
Iotek 7030	7.3	7.2	---	7.2
Whitener Package				
Unitane 0-110 (phr)	2.3	2.3	2.3	2.3
Eastobrite OB1 (phr)	0.025	0.025	0.025	0.025
Ultra Marine Blue (phr)	0.004	0.004	0.004	0.004
Final Ball Data				
Size	1.68"	1.68"	1.68"	1.68"
Weight	45.4g	45.4g	45.4g	45.4g
COR (X 1000)	770-780	770-780	770-780	770-780

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Definitions

Fillers

In a particularly preferred form of the invention, at least one layer of the golf ball contains at least one part by weight of a filler. Fillers preferably are used to adjust the density, flex modulus, mold release, and/or melt flow index of a layer. More preferably, at least when the filler is for adjustment of density or flex modulus of a layer, it is present in an amount of at least five parts by weight based upon 100 parts by weight of the layer composition. With some fillers, up to about 200 parts by weight probably can be used.

10 A density adjusting filler according to the invention preferably is a filler which has a specific gravity which is at least 0.05 and more preferably at least 0.1 higher or lower than the specific gravity of the layer composition. Particularly preferred density adjusting fillers have specific gravities which are higher than the specific gravity of the resin composition by 0.2 or more, even
15 more preferably by 2.0 or more.

A flex modulus adjusting filler according to the invention is a filler which, when used in an amount of e.g. 1 - 100 parts by weight based upon 100 parts by weight of resin composition, will raise or lower the flex modulus (ASTM D-790) of the resin composition by at least 1% and preferably at least 5% as
20 compared to the flex modulus of the resin composition without the inclusion of the flex modulus adjusting filler.

A mold release adjusting filler is a filler which allows for the easier removal of a part from a mold, and eliminates or reduces the need for external release agents which otherwise could be applied to the mold. A mold release
25 adjusting filler typically is used in an amount of up to about 2 weight percent based upon the total weight of the layer.

A melt flow index adjusting filler is a filler which increases or decreases the melt flow, or ease of processing of the composition.

The layers may contain coupling agents that increase adhesion of
30 materials within a particular layer e.g. to couple a filler to a resin composition,

or between adjacent layers. Non-limiting examples of coupling agents include titanates, zirconates and silanes. Coupling agents typically are used in amounts of 0.1 - 2 weight percent based upon the total weight of the composition in which the coupling agent is included.

5 A density adjusting filler is used to control the moment of inertia, and thus the initial spin rate of the ball and spin decay. The addition in one or more layers, and particularly in the outer cover layer of a filler with a lower specific gravity than the resin composition results in a decrease in moment of inertia and a higher initial spin rate than would result if no filler were used. The addition in
10 one or more of the cover layers, and particularly in the outer cover layer of a filler with a higher specific gravity than the resin composition, results in an increase in moment of inertia and a lower initial spin rate. High specific gravity fillers are preferred as less volume is used to achieve the desired inner cover total weight. Nonreinforcing fillers are also preferred as they have minimal
15 effect on COR. Preferably, the filler does not chemically react with the resin composition to a substantial degree, although some reaction may occur when, for example, zinc oxide is used in a shell layer which contains some ionomer.

The density-increasing fillers for use in the invention preferably have a specific gravity in the range of 1.0 - 20. The density-reducing fillers for use in
20 the invention preferably have a specific gravity of 0.06 - 1.4, and more preferably 0.06 - 0.90. The flex modulus increasing fillers have a reinforcing or stiffening effect due to their morphology, their interaction with the resin, or their inherent physical properties. The flex modulus reducing fillers have an opposite effect due to their relatively flexible properties compared to the matrix
25 resin. The melt flow index increasing fillers have a flow enhancing effect due to their relatively high melt flow versus the matrix. The melt flow index decreasing fillers have an opposite effect due to their relatively low melt flow index versus the matrix.

Fillers which may be employed in layers other than the outer cover layer
30 may be or are typically in a finely divided form, for example, in a size generally

less than about 20 mesh, preferably less than about 100 mesh U.S. standard size, except for fibers and flock, which are generally elongated. Flock and fiber sizes should be small enough to facilitate processing. Filler particle size will depend upon desired effect, cost, ease of addition, and dusting considerations. The filler

5 preferably is selected from the group consisting of precipitated hydrated silica, clay, talc, asbestos, glass fibers, aramid fibers, mica, calcium metasilicate, barium sulfate, zinc sulfide, lithopone, silicates, silicon carbide, diatomaceous earth, polyvinyl chloride, carbonates, metals, metal alloys, tungsten carbide, metal oxides, metal stearates, particulate carbonaceous materials, micro

10 balloons, and combinations thereof. Non-limiting examples of suitable fillers, their densities, and their preferred uses are as follows:

FILLER TABLE

Filler Type	Spec. Grav.	Comments
Precipitated hydrated silica	2	1,2
Clay	2.62	1,2
Talc	2.85	1,2
Asbestos	2.5	1,2
Glass fibers	2.55	1,2
Aramid fibers (KEVLAR®)	1.44	1,2
Mica	2.8	1,2
Calcium metasilicate	2.9	1,2
Barium sulfate	4.6	1,2
Zinc sulfide	4.1	1,2
Lithopone	4.2 - 4.3	1,2
Silicates	2.1	1,2
Silicon carbide platelets	3.18	1,2
Silicon carbide whiskers	3.2	1,2
Tungsten carbide	15.6	1
Diatomaceous earth	2.3	1,2
Polyvinyl chloride	1.41	1,2

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<u>Carbonates</u>		
Calcium carbonate	2.71	1,2
Magnesium carbonate	2.2	1,2
<u>Metals and Alloys (powders)</u>		
Titanium	4.51	1
Tungsten	19.35	1
Aluminum	2.7	1
Bismuth	9.78	1
Nickel	8.9	1
Molybdenum	10.2	1
Iron	7.86	1
Steel	7.8 - 7.9	1
Lead	11.4	1,2
Copper	8.94	1
Brass	8.2 - 8.4	1
Boron	2.34	1
Boron carbide whiskers	2.52	1,2
Bronze	8.70 - 8.74	1
Cobalt	8.92	1
Beryllium	1.84	1
Zinc	7.14	1
Tin	7.31	1
<u>Metal Oxides</u>		
Zinc oxide	5.57	1,2
Iron oxide	5.1	1,2
Aluminum oxide	4	
Titanium oxide	3.9 - 4.1	1,2
Magnesium oxide	3.3 - 3.5	1,2
Zirconium oxide	5.73	1,2

<u>Metal Stearates</u>		
Zinc stearate	1.09	3,4
Calcium stearate	1.03	3,4
Barium stearate	1.23	3,4
Lithium stearate	1.01	3,4
Magnesium stearate	1.03	3,4
<u>Particulate carbonaceous materials</u>		
Graphite	1.5 - 1.8	1,2
Carbon black	1.8	1,2
Natural bitumen	1.2 - 1.4	1,2
Cotton flock	1.3 - 1.4	1,2
Cellulose flock	1.15 - 1.5	1,2
Leather fiber	1.2 - 1.4	1,2
<u>Micro balloons</u>		
Glass	0.15 - 1.1	1,2
Ceramic	0.2 - 0.7	1,2
Fly ash	0.6 - 0.8	1,2
<u>Coupling Agents Adhesion Promoters</u>		
Titanates	0.95 - 1.17	
Zirconates	0.92 - 1.11	
Silane	0.95 - 1.2	

COMMENTS:

- 1 Particularly useful for adjusting density of the cover layer.
- 2 Particularly useful for adjusting flex modulus of the cover layer.
- 3 Particularly useful for adjusting mold release of the cover layer.
- 5 4 Particularly useful for increasing melt flow index of the cover layer.

All fillers except for metal stearates would be expected to reduce the melt flow index of an injection molded cover layer.

The amount of filler employed is primarily a function of weight requirements and distribution.

Scuff Resistance

The scuff resistance test was conducted in the following manner: a Top-Flite tour pitching wedge (1994) with box grooves was obtained and was mounted in a Miyamae driving machine. The club face was oriented for a square hit. The forward/backward tee position was adjusted so that the tee was four inches behind the point in the downswing where the club was vertical. The height of the tee and the toe-heel position of the club relative to the tee were adjusted in order that the center of the impact mark was about 3/4 of an inch above the sole and was centered to the heel across the face. The machine was operated at a club head speed of 125 feet per second. A minimum of three samples of each ball were tested. Each ball was hit three times. After testing, the balls were rated according to the following table:

<u>Rating</u>	<u>Type of Damage</u>
1	Little or no damage (groove markings or dents)
2	Small cuts and/or ripples in cover
3	Moderate amount of material lifted from ball surface, but still attached to ball
4	Material removed or barely attached

The balls that were tested were primed and top coated.

Cut Resistance

Cut resistance was measured in accordance with the following procedure: A golf ball was fired at 135 feet per second against the leading edge of a 1994 Top-Flite Tour pitching wedge, wherein the leading edge radius is 1/32 inch, the loft angle is 51 degrees, the sole radius is 2.5 inches, and the bounce angle is 7 degrees.

The cut resistance of the balls tested herein was evaluated on a scale of 1 - 5. A 5 represents a cut that extends completely through the cover to the core; a 4 represents a cut that does not extend completely through the cover but that

does break the surface; a 3 does not break the surface of the cover but does leave a permanent dent; a 2 leaves only a slight crease which is permanent but not as severe as 3; and a 1 represents virtually no visible indentation or damage of any sort.

5 Durability

Durability is determined by firing a golf ball at 135 ft/sec (at 72°F) into 5-sided steel pentagonal container, the walls of which are steel plates. The container 10, which is shown schematically in Fig. 1, has a 19 1/2 inch long insert plate 12 mounted therein, the central portion 14 of which has horizontally
10 extending square grooves on it which are intended to simulate a square grooved face of a golf club. The grooves, which are shown in an exaggerated form in Fig. 2, have a width 30 of 0.033 inches, a depth 32 of 0.100 inches, and are spaced apart from one another by land areas 34 having a width of 0.130 inches. The five walls 16 of the pentagonal container each have a length of 14 1/2
15 inches. The inlet wall is vertical and the insert plate is mounted such that it inclines upward 30° relative to a horizontal plane away from opening 20 in container 10. The ball travels 15 1/2 - 15 3/4 inches horizontally from its point of entry into the container 10 until it hits the square-grooved central portion 14 of insert plate 12. The angle between the line of trajectory of the ball and the
20 insert plate 12 is 30°. The balls are subjected to 70 or more blows (firings) and are inspected at regular intervals for breakage (i.e., any signs of cover cracking or delamination). If a microcrack forms in a ball, its speed will change and the operator is alerted. The operator then visually inspects the ball. If the microcrack cannot yet be observed, the ball is returned to the test until a crack
25 can be visually detected.

A ball is assigned a Durability Rating according to the following scale. A sample of twelve balls of the same type are obtained and are tested using the durability test apparatus described in the previous paragraph. If less than all of the balls in the sample survive 70 blows each without cracking, the ball is
30 assigned a Durability Rating of 1. If all of the balls survive 70 blows and one or

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two of the twelve balls crack before 100 blows, the ball is assigned a Durability Rating of 2. If all twelve balls in the sample survive 100 blows each, but seven or more balls crack at less than 200 blows each, the ball is assigned a Durability Rating of 3. If all twelve balls in the sample survive 100 blows and at least six
5 out of the twelve balls in the sample also survive 200 blows, the balls is assigned a Durability Rating of 4.

Shore D Hardness

As used herein, "Shore D hardness" of a cover is measured generally in accordance with ASTM D-2240, except the measurements are made on the
10 curved surface of a molded cover, rather than on a plaque. Furthermore, the Shore D hardness of the cover is measured while the cover remains over the core. When a hardness measurement is made on a dimpled cover, Shore D hardness is measured at a land area of the dimpled cover.

Coefficient of Restitution

15 The resilience or coefficient of restitution (COR) of a golf ball is the constant "e," which is the ratio of the relative velocity of an elastic sphere after direct impact to that before impact. As a result, the COR ("e") can vary from 0 to 1, with 1 being equivalent to a perfectly or completely elastic collision and 0 being equivalent to a perfectly or completely inelastic collision.

20 COR, along with additional factors such as club head speed, club head mass, ball weight, ball size and density, spin rate, angle of trajectory and surface configuration (i.e., dimple pattern and area of dimple coverage) as well as environmental conditions (e.g. temperature, moisture, atmospheric pressure, wind, etc.) generally determine the distance a ball will travel when hit. Along
25 this line, the distance a golf ball will travel under controlled environmental conditions is a function of the speed and mass of the club and size, density and resilience (COR) of the ball and other factors. The initial velocity of the club, the mass of the club and the angle of the ball's departure are essentially provided by the golfer upon striking. Since club head, club head mass, the angle of
30 trajectory and environmental conditions are not determinants controllable by

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golf ball producers and the ball size and weight are set by the U.S.G.A., these are not factors of concern among golf ball manufacturers. The factors or determinants of interest with respect to improved distance are generally the coefficient of restitution (COR) and the surface configuration (dimple pattern,
5 ratio of land area to dimple area, etc.) of the ball.

The COR in solid core balls is a function of the composition of the molded core and of the cover. The molded core and/or cover may be comprised of one or more layers such as in multi-layered balls. In balls containing a wound core (i.e., balls comprising a liquid or solid center, elastic windings, and
10 a cover), the coefficient of restitution is a function of not only the composition of the center and cover, but also the composition and tension of the elastomeric windings. As in the solid core balls, the center and cover of a wound core ball may also consist of one or more layers.

The coefficient of restitution is the ratio of the outgoing velocity to the
15 incoming velocity. In the examples of this application, the coefficient of restitution of a golf ball was measured by propelling a ball horizontally at a speed of 125 ± 5 feet per second (fps) and corrected to 125 fps against a generally vertical, hard, flat steel plate and measuring the ball's incoming and outgoing velocity electronically. Speeds were measured with a pair of Oehler
20 Mark 55 ballistic screens available from Oehler Research, Inc., P.O. Box 9135, Austin, Texas 78766, which provide a timing pulse when an object passes through them. The screens were separated by 36" and are located 25.25" and 61.25" from the rebound wall. The ball speed was measured by timing the pulses from screen 1 to screen 2 on the way into the rebound wall (as the
25 average speed of the ball over 36"), and then the exit speed was timed from screen 2 to screen 1 over the same distance. The rebound wall was tilted 2 degrees from a vertical plane to allow the ball to rebound slightly downward in order to miss the edge of the cannon that fired it. The rebound wall is solid steel 2.0 inches thick.

As indicated above, the incoming speed should be 125 \pm 5 fps but corrected to 125 fps. The correlation between COR and forward or incoming speed has been studied and a correction has been made over the \pm 5 fps range so that the COR is reported as if the ball had an incoming speed of exactly 125.0
5 fps.

The coefficient of restitution must be carefully controlled in all commercial golf balls if the ball is to be within the specifications regulated by the United States Golf Association (U.S.G.A.). As mentioned to some degree above, the U.S.G.A. standards indicate that a "regulation" ball cannot have an
10 initial velocity exceeding 255 feet per second in an atmosphere of 75 F. when tested on a U.S.G.A. machine. Since the coefficient of restitution of a ball is related to the ball's initial velocity, it is highly desirable to produce a ball having sufficiently high coefficient of restitution to closely approach the U.S.G.A. limit on initial velocity, while having an ample degree of softness (i.e., hardness) to
15 produce enhanced playability (i.e., spin, etc.).

Compression

PGA compression is another important property involved in the performance of a golf ball. The compression of the ball can affect the playability of the ball on striking and the sound or "click" produced. Similarly,
20 compression can effect the "feel" of the ball (i.e., hard or soft responsive feel), particularly in chipping and putting.

Moreover, while compression itself has little bearing on the distance performance of a ball, compression can affect the playability of the ball on striking. The degree of compression of a ball against the club face and the
25 softness of the cover strongly influences the resultant spin rate. Typically, a softer cover will produce a higher spin rate than a harder cover. Additionally, a harder core will produce a higher spin rate than a softer core. This is because at impact a hard core serves to compress the cover of the ball against the face of the club to a much greater degree than a soft core thereby resulting in more
30 "grab" of the ball on the clubface and subsequent higher spin rates. In effect the

cover is squeezed between the relatively incompressible core and clubhead. When a softer core is used, the cover is under much less compressive stress than when a harder core is used and therefore does not contact the clubface as intimately. This results in lower spin rates.

5 The term "compression" utilized in the golf ball trade generally defines the overall deflection that a golf ball undergoes when subjected to a compressive load. For example, PGA compression indicates the amount of change in golf ball's shape upon striking. The development of solid core technology in two-piece balls has allowed for much more precise control of compression in
10 comparison to thread wound three-piece balls. This is because in the manufacture of solid core balls, the amount of deflection or deformation is precisely controlled by the chemical formula used in making the cores. This differs from wound three-piece balls wherein compression is controlled in part by the winding process of the elastic thread. Thus, two-piece and multilayer
15 solid core balls exhibit much more consistent compression readings than balls having wound cores such as the thread wound three-piece balls.

In the past, PGA compression related to a scale of from 0 to 200 given to a golf ball. The lower the PGA compression value, the softer the feel of the ball upon striking. In practice, tournament quality balls have compression ratings
20 around 70 - 110, preferably around 80 to 100.

In determining PGA compression using the 0 - 200 scale, a standard force is applied to the external surface of the ball. A ball which exhibits no deflection (0.0 inches in deflection) is rated 200 and a ball which deflects 2/10th of an inch (0.2 inches) is rated 0. Every change of .001 of an inch in deflection represents
25 a 1 point drop in compression. Consequently, a ball which deflects 0.1 inches (100 x .001 inches) has a PGA compression value of 100 (i.e., 200 - 100) and a ball which deflects 0.110 inches (110 x .001 inches) has a PGA compression of 90 (i.e., 200 - 110).

In order to assist in the determination of compression, several devices
30 have been employed by the industry. For example, PGA compression is

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determined by an apparatus fashioned in the form of a small press with an upper and lower anvil. The upper anvil is at rest against a 200-pound die spring, and the lower anvil is movable through 0.300 inches by means of a crank mechanism. In its open position the gap between the anvils is 1.780 inches

5. allowing a clearance of 0.100 inches for insertion of the ball. As the lower anvil is raised by the crank, it compresses the ball against the upper anvil, such compression occurring during the last 0.200 inches of stroke of the lower anvil, the ball then loading the upper anvil which in turn loads the spring. The equilibrium point of the upper anvil is measured by a dial micrometer if the
10 anvil is deflected by the ball more than 0.100 inches (less deflection is simply regarded as zero compression) and the reading on the micrometer dial is referred to as the compression of the ball. In practice, tournament quality balls have compression ratings around 80 to 100 which means that the upper anvil was deflected a total of 0.120 to 0.100 inches.

15 An example to determine PGA compression can be shown by utilizing a golf ball compression tester produced by Atti Engineering Corporation of Newark, N.J. The value obtained by this tester relates to an arbitrary value expressed by a number which may range from 0 to 100, although a value of 200 can be measured as indicated by two revolutions of the dial indicator on the
20 apparatus. The value obtained defines the deflection that a golf ball undergoes when subjected to compressive loading. The Atti test apparatus consists of a lower movable platform and an upper movable spring-loaded anvil. The dial indicator is mounted such that it measures the upward movement of the springloaded anvil. The golf ball to be tested is placed in the lower platform,
25 which is then raised a fixed distance. The upper portion of the golf ball comes in contact with and exerts a pressure on the springloaded anvil. Depending upon the distance of the golf ball to be compressed, the upper anvil is forced upward against the spring.

Alternative devices have also been employed to determine compression.
30 For example, Applicant also utilizes a modified Riehle Compression Machine

originally produced by Riehle Bros. Testing Machine Company, Phil., PA to evaluate compression of the various components (i.e., cores, mantle cover balls, finished balls, etc.) of the golf balls. The Riehle compression device determines deformation in thousandths of an inch under a fixed initialized load of 200
5 pounds. Using such a device, a Riehle compression of 61 corresponds to a deflection under load of 0.061 inches.

Additionally, an approximate relationship between Riehle compression and PGA compression exists for balls of the same size. It has been determined by Applicant that Riehle compression corresponds to PGA compression by the
10 general formula $\text{PGA compression} = 160 - \text{Riehle compression}$. Consequently, 80 Riehle compression corresponds to 80 PGA compression, 70 Riehle compression corresponds to 90 PGA compression, and 60 Riehle compression corresponds to 100 PGA compression. For reporting purposes, Applicant's compression values are usually measured as Riehle compression and converted
15 to PGA compression.

Furthermore, additional compression devices may also be utilized to monitor golf ball compression so long as the correlation to PGA compression is known. These devices have been designed, such as a Whitney Tester, to correlate or correspond to PGA compression through a set relationship or formula.

20

What is claimed is:

1. A process of making a multi-piece golf ball comprising making at least one of a cover component and a core component of the ball by mixing two or more reactants that react and form a reaction product with a flex modulus of 5 - 310 kpsi in a reaction time of about 5 minutes or less, the component having a thickness of at least 0.01 inches and a demold time of 10 minutes or less.

2. A process according to claim 1, wherein the reaction product comprises at least one member selected from the group consisting of polyurethanes, polyureas, epoxies and unsaturated polyesters.

3. A process according to claim 1, wherein the reaction process comprises reaction injection molding.

4. A process according to claim 1, wherein the reaction product comprises at least one member selected from the group consisting of polyurethane and polyurea.

5. A process according to claim 4, wherein the reaction product with a flex modulus of 5 - 300 kpsi is formed in a reaction time of about 3 minutes or less.

6. A process according to claim 4, wherein the component has a thickness of at least 0.02 inches.

7. A process according to claim 4, wherein the component includes a cover component.

8. A process according to claim 7, wherein the cover component is a dimpled cover layer and the cover component has a thickness of at least 0.02 inches.

9. A process according to claim 7, wherein the cover component has a hardness of 20 - 95 Shore D.

10. A process according to claim 7, wherein the cover component has a hardness of 30 - 75 Shore D.

11. A process according to claim 1, wherein the component includes a core component.

12. A process according to claim 2, further including the step of recycling at least a portion of the reaction product.

13. A process according to claim 12, wherein the reaction product is recycled by glycolysis.

5 14. A multi-piece golf ball comprising a reaction injection molded material comprising polyurethane/polyurea. *process*

15. A golf ball according to claim 14, wherein the reaction injection molded material comprising polyurethane/polyurea includes at least one of ether functional groups and ester functional groups.

10 16. A golf ball according to claim 14, wherein at least 5% of the polyurethane/polyurea is formed from molecules obtained by recycling a material comprising one of polyurethane, polyurea, polyester, and polyethylene glycol.

15 17. A golf ball according to claim 14, wherein recycling takes place by glycolysis.

18. A golf ball according to claim 14, wherein the ball has a core and a cover and at least the cover comprises reaction injection molded polyurethane/polyurea material.

20 19. A golf ball according to claim 18, wherein the ball includes an exterior coating surrounding the cover.

20. A golf ball according to claim 18, wherein the core is solid, multi-layer, wound, liquid filled, metal filled and/or foamed.

Just a 21. A golf ball according to claim 18, wherein the cover has a flex modulus of 5 - 310 kpsi.

25 22. A golf ball according to claim 18, wherein the cover has a flex modulus of 5 - 100 kpsi.

23. A golf ball according to claim 18, wherein the exterior coating is applied over the cover after molding of the cover.

30 24. A golf ball according to claim 18, wherein the hardness of the cover is 20 - 95 Shore D.

25. A golf ball according to claim 18, wherein the hardness of the cover is 30 - 75 Shore D.

26. A golf ball according to claim 25, wherein the flexural modulus of the cover is in the range 5 to 100 kpsi.

5 27. A golf ball according to claim 18, wherein the flexural modulus of the cover is higher than that of the core.

28. A golf ball according to claim 18, wherein the ball has a multi-layer cover.

29. A golf ball according to claim 18, wherein the cover comprises a
10 reaction injection molded material comprising polyurethane and further comprises at least one member selected from the group consisting of optical brightener, pigment, dye, antioxidant, and UV light stabilizer.

30. A golf ball according to claim 18, wherein the cover further comprises a filler.

15 31. A golf ball according to claim 30, wherein the filler includes at least one member selected from the group consisting of glass, metal, minerals, oxides, sulfides, titanates, polymeric resins and ceramics.

32. A golf ball according to claim 14, wherein the ball has a core and a cover, and at least the core comprises a reaction injection molded
20 polyurethane/polyurea material.

33. A golf ball according to claim 30, wherein the core comprises at least two components and at least one core component comprises reaction injection molded polyurethane/polyurea material.

34. A golf ball according to claim 14, wherein the ball has a core, and a
25 cover, each of which comprises reaction injection molded polyurethane/polyurea material.

35. A golf ball according to claim 30, wherein the cover comprises an ionomer.

36. A golf ball according to claim 14, wherein the polyurethane/polyurea
30 material incorporates meta-tetramethylxylylene diisocyanate.

37. A golf ball according to claim 18, wherein the cover has a generally uniform consistency both at the seam and the poles.

38. A process for producing a golf ball including the step (a) of: reaction injection molding a polyurethane/polyurea material to form at least one of a core layer and a cover layer of the ball.

39. A process according to claim 38, further comprising the step of (b) recycling at least 20% of the polyurethane/polyurea that is produced in connection with step (a) but which is not incorporated into the ball during that step

40. A process for producing a golf ball comprising (a) forming a core, (b) covering the core, and (c) coating and adding indicia to the covered ball, wherein at least one of steps (a) and (b) comprises reaction injection molding of a polyurethane/polyurea material.

41. A process according to claim 38, further comprising the step of (d) recycling at least 20% of the RIM-produced material comprising polyurethane that was produced consequent to step (a).

42. A golf ball comprising at least one fast-chemical-reaction-produced layer, said layer having a flex modulus of 5 - 310 kpsi in a reaction time of 5 minutes or less and a thickness of at least 0.01".

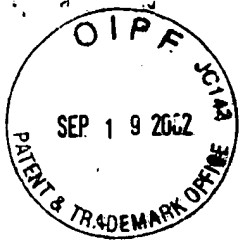
43. A golf ball according to claim 42, wherein said ball has a multi-layer cover and said at least one fast-chemical-reaction-produced layer is an inner cover layer.

44. A golf ball having a core and a cover, the cover comprising polyurethane/polyurea which is formed from reactants, 5 - 100 weight percent of which are obtained from recycled polyurethane/polyurea.

ABSTRACT OF THE DISCLOSURE

Disclosed herein is a golf ball comprising fast-chemical-reaction-produced component, such as a component which comprises a reaction injection molded polyurethane material. A process of making a golf ball by forming at least one
5 core and/or cover component of the ball by mixing two or more reactants that react and form a reaction product with a flex modulus of 5 - 310 kpsi in a reaction time of about 5 minutes or less, the component having a thickness of at least 0.01 inches and a demold time of 10 minutes or less is disclosed. In one
10 preferred form of the invention, excess polyurethane from forming golf ball covers is recycled by using it to form golf ball cores.

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Application for
United States Letters Patent

REACTION INJECTION MOLDED GOLF BALL

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Background

This invention relates to golf balls, and, more particularly, to golf balls and golf ball products which are formed by reaction injection molding or liquid injection molding fast curing thermoset polyurethane compounds.

Golf balls which are currently available fall into two general categories - balls which include a balata cover and balls which include a more durable, cut-resistant cover. Balata covers are made from natural balata, synthetic balata, or a blend of natural and synthetic balata. Most cut-resistant covers utilize Surlyn ionomer, which is an ionic copolymer of methacrylic acid and ethylene available from E. I du Pont de Nemours & Co. Other cut-resistant materials which can be used in golf ball covers are ionic copolymers available from Exxon under the name Iotek, which are similar to Surlyn ionic copolymers except that acrylic acid is used rather than methacrylic acid.

A number of golfers, primarily professional and low handicap golfers, prefer balata covered balls because of the higher spin rate, control, "feel," and "click" which balata provides. "Feel" is the overall sensation imparted to a golfer when the ball is hit, and "click" refers to the sound made when the clubhead hits the ball. However, balata covered balls are more expensive and are less resistant to cutting than Surlyn covered balls.

Conventional balata covered golf balls are produced by winding resilient, low heat-resistant elastic thread over a soft

rubber or liquid rubber center, which must first be frozen to permit winding the rubber thread, and molding a conventional soft balata cover over the windings. The balata is conventionally vulcanized or crosslinked by using sulfur as the crosslinker or vulcanizing agent.

Surlyn covered balls are cheaper than balata balls not only because Surlyn is cheaper than balata but because Surlyn balls can be processed after molding much easier and faster than balata balls.

The term "3 piece" is commonly used to refer to a golf ball which has a center, a layer of elastic windings over the center, and a cover. The term "2 piece" is used to refer to a golf ball which has a solid core and a cover.

Surlyn covered balls can be either 3 piece or 2 piece balls. Other variations include a solid core and two or more cover layers and a solid core, a mantle surrounding the core, and one or more cover layers over the mantle.

Polyurethane materials have been used in golf ball construction (primarily as golf ball covers) for many years, with varying levels of success.

Thermoplastic polyurethanes have been used, alone and in blends with other materials, as golf ball covers. However, the balls made using thermoplastic polyurethanes (solid core construction) have generally had poor resilience properties. Thermoplastic polyurethanes are generally unsuitable for use as covers on wound golf balls as the processing temperatures

required (350+°F) to obtain suitable flow of the polyurethane materials into polyisoprene thread would degrade the thread used in wound golf ball cores. The thread will degrade, and lose the resilience properties necessary to obtain premium performance.

More recently, work has been performed in using slow curing, thermoset polyurethane compounds as golf ball covers (see U.S. Patent Nos. 4,123,061 and 5,334,673 for a description of using a liquid cast, slow curing polyurethane). Although these polyurethane compounds produce better golf ball properties than thermoplastic polyurethane materials, the methods for processing these materials (as described in U.S. Patent Nos. 3,989,568 and 4,123,061 and European Patent Publication 0 578 466 A1) are difficult, time-consuming and cost-inefficient.

Summary of the Invention

The invention uses an improved method for processing fast cure thermoset polyurethane compounds by reaction injection molding (RIM) or liquid injection molding (LIM) low viscosity polyurethane components, which provides short cycle, low cost processing conditions. The liquid components are injected at low temperatures and pressures compared to thermoplastic polyurethanes, and will not cause degradation of the threads of wound cores. Reaction injection molding of thermoset polyurethane compounds are suitable for molding solid golf balls, core or center for solid or wound golf balls, the inner cover layer or mantle layer of a solid golf ball, and the outer cover

layer of either a solid or a wound golf ball.

D scription of the Drawings

The invention will be explained in conjunction with an illustrative embodiment shown in the accompanying drawing, in which --

Figure 1 is a sectional view of a solid polyurethane golf ball which is formed in accordance with the invention;

Figure 2 is a sectional view of a two piece golf ball with a polyurethane cover which is formed in accordance with the invention;

Figure 3 is a sectional view of a golf ball having a mantle and a cover, either or both of which are formed in accordance with the invention;

Figure 4 is a sectional view of a solid golf ball having two cover layers, either or both of which are formed in accordance with the invention;

Figure 5 is a sectional view of a 3 piece wound golf ball with a cover which is formed in accordance with the invention;

Figure 6 is a schematic diagram of a mixing apparatus for forming polyurethane compounds;

Figure 7 is a side view, partially in section, of a two-part mold for reaction injection molding golf ball products; and

Figure 8 is a sectional view of a mold for reaction

injection molding golf ball products.

Description of Specific Embodiments

Figure 1 illustrates a solid golf ball 10 which is reaction injection molded from thermoset polyurethane as will be described in detail herein. The ball includes a homogeneous core 11 having an outer surface which includes conventional concave dimples 12.

Figure 2 illustrates a solid 2 piece golf ball 13 which includes a solid core 14 and a dimpled cover 15 which is reaction injection molded from thermoset polyurethane in accordance with the invention. 8

Figure 3 illustrates a solid ball 16 which includes a core 17, a mantle 18, and a dimpled cover 19. Either or both of the mantle and the cover can be reaction injection molded from thermoset polyurethane.

Figure 4 illustrates a solid ball 20 having a core 21 and a two-layer cover 22. The cover includes an inner layer 23 and an outer layer 24. Either or both of the cover layers can be reaction injection molded from thermoset polyurethane.

Figure 5 illustrates a 3 piece ball 25 which includes a center 26, a layer 27 of elastic windings, and a cover 28. The cover is reaction injected molded from thermoset polyurethane.

Polyurethane compounds suitable for reaction injection molding can be made by mixing the following components:

1. An aromatic or aliphatic diisocyanate (and/or 25

diisocyanate prepolymer) having a viscosity (at 25°C) of less than 1,000 cps. Examples of suitable diisocyanate are as follows:

- a) TDI (Meta-toluene diisocyanate);
- b) MDI (4,4'-Diphenylmethane diisocyanate);
- c) PMDI (Polymeric diisocyanate);
- d) TODI (3,3'-dimethyl-4,4'biphenyl diisocyanate);
- e) NDI (Naphthalene diisocyanate);
- f) PPDI (Para-phenylene diisocyanate);

2. A polyol and/or diamine curing agent, having a viscosity (at 25°C) of less than 2,000 cps. Examples of suitable polyol/diamine curing agents are as follows:

- a) Polyether-based polyols (such as polypropylene oxide based polyols);
- b) Amine curing agents (such as Diethyltoluenediamine);
- c) Polyester-based polyols, (such as):
 - i. Adipates, isophthalates, phthalates, terephthalates;
 - ii. Polycaprolactones;
 - iii. polycarbonates;

Other components can also be used for making fast curing thermoset polyurethane compounds.

The polyurethane compounds can include additives such as chain extenders (polyol or polyamine), stabilizers, and

colorants.

Figure 6 illustrates a high pressure polyurethane metering/injection machine 31 which is suitable for use with the invention. The prepolymer and curing agent for making the polyurethane compound are mixed in mixing tanks 32 and 33. The mixing tanks include stirring rods 34 and 35 which are rotated by motors 36 and 37. Each component is metered by a metering unit 38, 39 to an impingement mixing head 40. The pressure of the component in tank 33 is controlled by pressure control valve 41, and excessive pressure can be relieved by relief valves 42. A bypass valve 43 permits low pressure recirculation back to the mixing tank 32 when the mixing head is not being filled. 2

Once the reacting materials have been introduced into the impingement mixing head 40, the mixing head is connected to a mold, and the reacting materials are transferred to the mold. The mixing head can include an injection button for forcing the reacting materials from the mixing head to the mold under relatively low pressure. 18

Figure 7 illustrates a reaction injection mold 45 for molding thermoset polyurethane golf ball products. The mold 45 is a two-part mold and includes mold halves 46 and 47. Each mold half includes a mold 49 which is mounted in a cavity plate 49. The mold is provided with a generally hemispherical mold cavity 50 which is defined by a mold surface 51.

The cavity plate is secured to a retainer plate 53 by pins 54. An adapter plate 55 is secured to the retainer plate

and supports a pin block 56. A plurality of pins 57 are mounted for reciprocation by a hydraulic cylinder 58. The pins may be extended into the mold cavity to hold the core in the mold cavity so that reacting materials can be injected around the core. The pins could also be controlled pneumatically or electronically. 5

If a polyurethane cover or mantle is to be molded over 6 a core, the pins 57 are extended into the molds 48, the core is positioned between the mold halves, and the mold halves are closed. The reacting materials are injected into the mold and fill the space between the core and the mold surfaces 51. Once the mold cavity is filled, the pins 57 are retracted. If a cover is being molded, the mold surfaces 51 of the molds 48 are provided with conventional projections for forming dimples in the molded cover. The pins 57 are only partially retracted so that the ends of the pins extend beyond the mold surfaces to form dimples in the cover. If a mantle or an inner cover layer is being molded, the pins retract so that they are flush with the mold surfaces 51 and form part of the spherical mold surface. 18

The time needed for mixing and flowing the reacting materials into the mold will vary from 0.5 seconds to 10 seconds 20 depending upon the material and the ratio of prepolymer and curative. To assist in curing of materials to attain a workable gel time, temperature of the mold will need to be maintained between 70 and 200 degrees F. After the gel time is complete, the mold is opened to remove the molded part. The pins 57 can be extended at this time to aid in removing the part and to ready

the mold for the start of the next cycle.

The molds 48 can be changed depending upon the part which is being molded. The diameter of a core or a mantle-covered core which can be inserted into the mold can range from 0.75 inch to 1.610 inch. If a solid polyurethane golf ball is to be molded, the mold halves are closed without inserting a core. Reacting material is injected into the entire cavity.

Figure 8 illustrates another mold 61 for reaction injection molding golf ball products in accordance with the invention. The mold is provided with a mold cavity 62 and an inlet opening 63 for the reacting materials. The reacting materials pass through mixing chambers 64 and through fanned gates 65 into the cavity. The fanned or shallower gates lessen or prevent the formation of air bubbles during molding. An overflow chamber 66 above the mold collects air which escapes from the reacting materials. After the gel time is complete, the mold is opened to remove the molded part.

As previously described, reaction injection molding can be used to mold a solid core or golf ball, a mantle layer over a core, an inner or outer cover layer of a two-cover ball, and/or a cover for a wound golf ball. The foregoing molded parts are referred to generically herein as "golf ball products."

Example

The invention will be further explained with reference to the following specific example.

Polyol/diamine component is maintained at a temperature of 80-150°F, more preferably at a temperature of 95-120°F.

Isocyanate/isocyanate prepolymer component is maintained at a temperature of 80-130°F, more preferably at a temperature of 95-120°F.

Mold temperature is kept between 70 and 200 degrees F. Preferable mold temperature is 140-170°F.

Molding Process:

1. Core (wound core, solid core, or solid core with mantle) is inserted into the mold. Pins are extended into the mold cavity (cavities) to center the core(s). Mold is closed.

2. Polyol/diamine component and isocyanate component are shot into the mixing head as follows:

- Polyol-diamine is shot into the mixing head at a pressure of 1,200 - 2,900 psi, preferably at a pressure of about 2,000 psi.

- Isocyanate component is shot into the mixing head at a pressure of 1,200 - 2,900 psi, preferably at a pressure of about 2,500 psi.

The ratio of Polyol/diamine component to isocyanate component will vary based upon the grade of material utilized (hardness level, etc.)

Polyol/diamine component and isocyanate component are shot into the mixing head at a combined "throughput" amount of 35-200 g/s, for a mixing time of 0.5-10 seconds, based upon the

reaction time and amount of material required to fill cavity (cavities).

Note: for single cavity mold, preferable conditions are a throughput rate of 35-50g/s and a mixing time of 0.5-1.0 seconds.

3. Mixture of Polyol/diamine and isocyanate components are injected into the mold, at a set (low) pressure. Injection is generally completed within 5 seconds of the end of the "Impingement" mixing of the polyol/diamine and isocyanate components.

4. Pins are pulled slightly before, at, or slightly after the completion of the material injection. (Example: For single cavity mold with 1.0 second mixing/injection time, pins are pulled at between 1.2 and 1.5 seconds.)

5. Materials generally are cured (gel) enough for demolding within 10-60 seconds (This is dependent upon the cure rate of the system and temperature of the mold). Molded product can be left in the mold for longer periods of time if desired, with no detrimental effect on product properties.

While in the foregoing specification a detailed description of specific embodiments of the invention were set forth for the purpose of illustration, it will be understood that many of the details herein given can be varied considerably by those skilled in the art without departing from the spirit and scope of the invention.

WE CLAIM:

1. A method of making a golf ball product comprising the steps of:

mixing a polyurethane prepolymer and a curing agent to form a reaction mixture,

introducing the reaction mixture into a mold having a generally spherical cavity,

allowing the reaction mixture to gel and form a generally spherical molded product, and

opening the mold and removing the molded product.

2. The method of claim 1 in which the reaction mixture is a fast curing thermoset polyurethane compound.

3. The method of claim 1 in which the polyurethane prepolymer has a viscosity of less than 1000 cps.

4. The method of claim 3 in which the curing agent has a viscosity of less than 2000 cps at 25°C.

5. The method of claim 1 in which the curing agent has a viscosity of less than 2000 cps at 25°C.

6. The method of claim 1 in which the mold cavity is provided by a mold surface having projections for forming dimples in the molded product.

7. A method of forming a cover on a golf ball comprising:

inserting a generally spherical uncovered golf ball product in a mold, the mold having a generally spherical mold

surface which is spaced from the golf ball product,

mixing a polyurethane prepolymer and a curing agent to form a reaction mixture,

introducing the reaction mixture into the mold to cover the golf ball product therein,

allowing the reaction mixture to gel and form a golf ball, and

opening the mold and removing the golf ball.

8. The method of claim 1 in which the generally spherical mold surface includes projections for forming dimples in the cover of the golf ball.

9. The method of claim 7 in which the reaction mixture is a fast curing thermoset polyurethane compound.

10. The method of claim 7 in which the polyurethane prepolymer has a viscosity of less than 1000 cps.

11. The method of claim 7 in which the curing agent has a viscosity of less than 2000 cps at 25°C.

12. The method of claim 7 in which the uncovered golf ball product is a wound golf ball core.

13. The method of claim 7 in which the uncovered golf ball product is a solid core.

14. A golf ball comprising a core and a cover wherein the cover is made from a fast curing thermoset polyurethane composition comprising an aromatic or aliphatic diisocyanate and/or diisocyanate prepolymer having a viscosity of less than 1000 cps, and a polyol and/or amine curing agent having a

viscosity of less than 2000 cps at 25°C.

15. The golf ball of claim 14 in which the aromatic diisocyanate or diisocyanate prepolymer is selected from the class consisting of TDI, MDI, PMDI, TODI, NDI, and PPDI.

16. The golf ball of claim 15 in which the curing agent(s) are selected from the class of polyether-based polyols, polyester-based polyols, diamines, or a combination thereof.

17. The golf ball of claim 13 in which the curing agent(s) are selected from the class of polyether-based polyols, polyester-based polyols, diamines, or a combination thereof.

REACTION INJECTION MOLDED GOLF BALL

Abstract of the Disclosure

Golf ball products are made by reaction injection molding (RIM) or liquid injection molding (LIM) fast curing thermoset polyurethane compounds. A polyurethane prepolymer and a curing agent are mixed and injected as low temperature and pressure into a mold where the reaction mixture gels. Reaction injection molding or liquid injection molding fast curing thermoset polyurethane can be used for molding solid golf balls, core or center for solid or wound golf balls, the inner cover or mantle layer of a solid golf ball, and the outer cover layer of either a solid or a wound golf ball.

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

REACTION INJECTION MOLDED GOLF BALL

the specification of which:

X is attached hereto

_____ was filed on _____
Application Serial No. _____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this applicaiton in accordance with Title 37, Code of Federal Regulations, §1.56(a) (a copy of which is attached).

I hereby claim foreign priority benefits under Title 35, United States code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

<u> </u>	<u> </u>	<u> </u>	PRIORITY	CLAIMED
(Number)	(Country)	(Day/Month/Year Filed)	<u> </u> YES	<u> </u> NO

			PRIORITY	CLAIMED
<u>(Number)</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	<u>YES</u>	<u>NO</u>

_____ hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below, and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to

disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the natural or PCT international filing date of this application:

<u>(Application Serial No.)</u>	<u>(Filing Date)</u>	<u>(Status)</u> (patented, pending, abandoned)
<u>(Application Serial No.)</u>	<u>(Filing Date)</u>	<u>(Status)</u> (patented, pending, abandoned)

POWER OF ATTORNEY: As named inventor, I hereby appoint the following attorney(s) and/or agent(s) with full powers of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

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We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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§ 1.56 Duty to disclose information material to patentability.

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office,

which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known

to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

FIG. 1

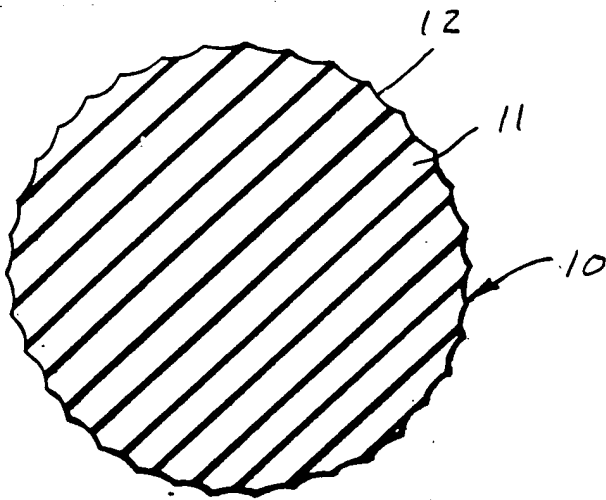


FIG. 2

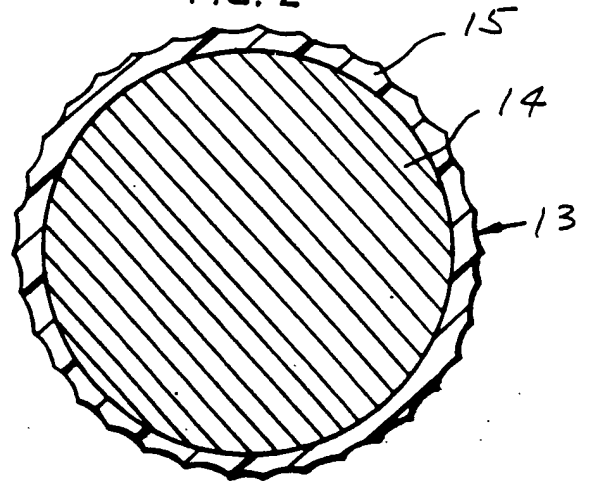


FIG. 3

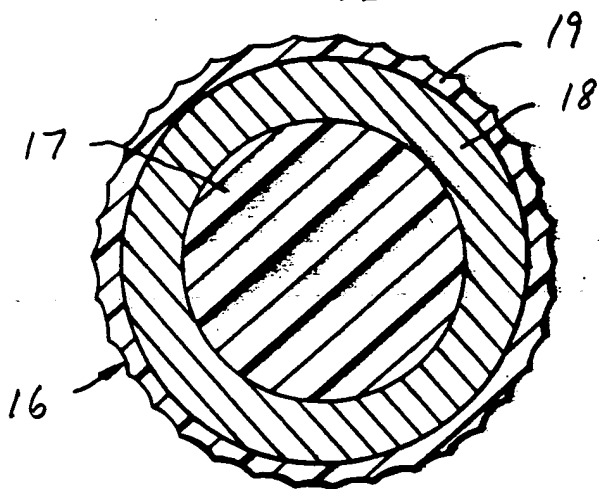


FIG. 4

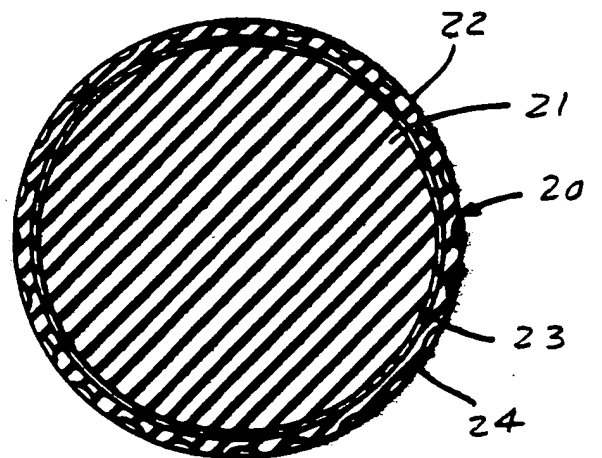


FIG. 5

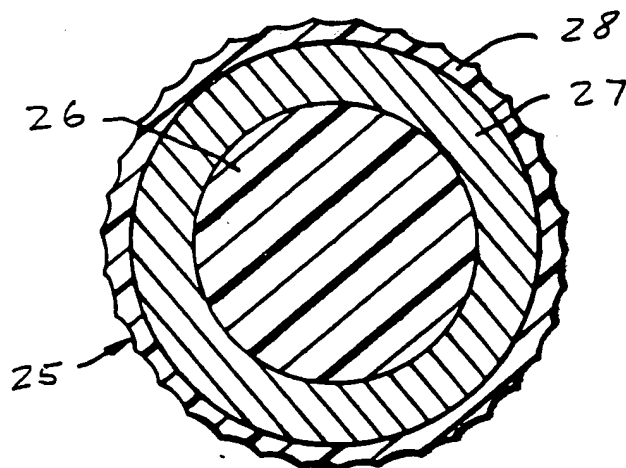


FIG. 6

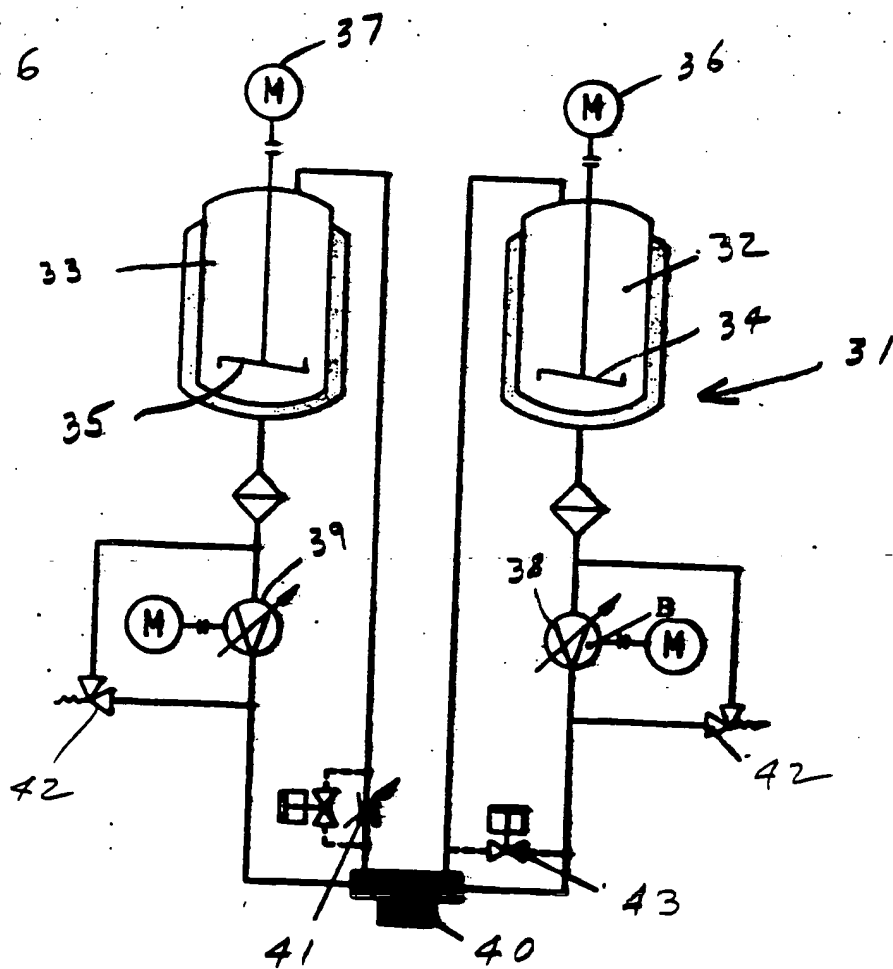


FIG. 7

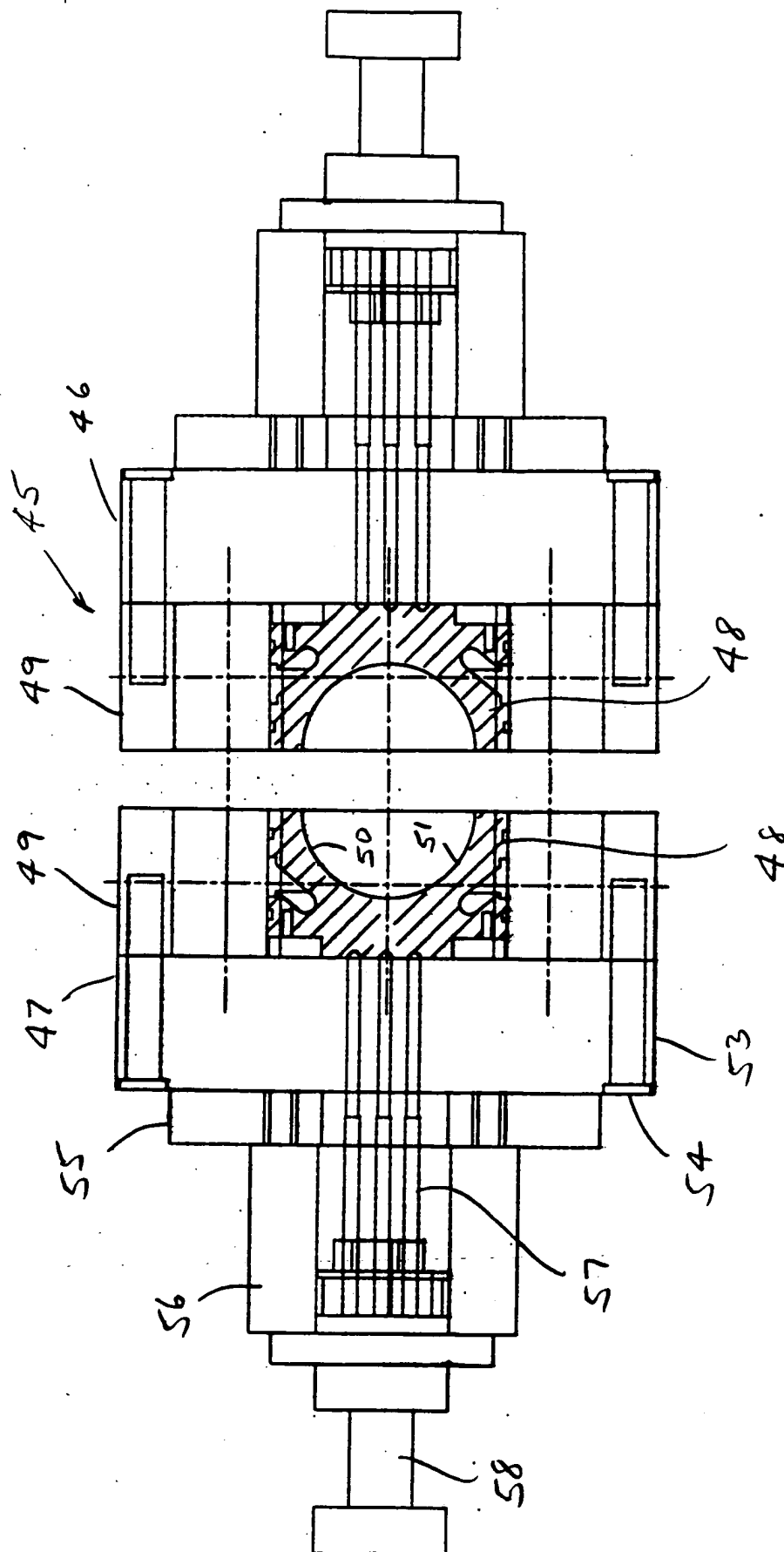


FIG. 8

